Degenkolb

Rating form completed by
Priscilla Nguyen, Jay Yin

Text in green is to be part of UC Santa Cruz building database and may be part of UCOP database

DATE: 2019-06-30

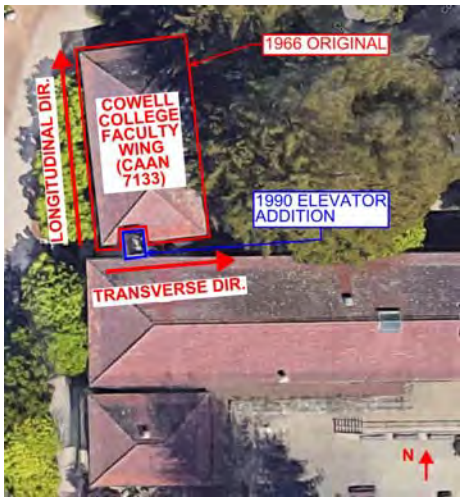
HOLLY J RAZZANO
REGISTERED PROFESSIONAL ENGINEER
No. 4107
EXP. 3/31/21
STRUCTURAL
STATE OF CALIFORNIA

6/28/19

UC Santa Cruz building seismic ratings

Cowell College Faculty Wing, Cowell College

CAAN #7133
518 Cowell-Stevenson Road, Santa Cruz, CA 95064
UCSC Campus: Main Campus



Rating summary	Entry	Notes
UC Seismic Performance Level (rating)	V (Poor)	
Rating basis	Tier 1	ASCE 41-17[1]
Date of rating	2019	
Recommended UC Santa Cruz priority category for retrofit	Priority A	Priority A=Retrofit ASAP Priority B=Retrofit at next permit application
Ballpark total construction cost to retrofit to IV rating[2]	Medium ($50/sf-$200/sf)	See recommendations on further evaluation and retrofit.
Is 2018-2019 rating required by UCOP?	Yes	Building was not previously rated
Further evaluation recommended?	Yes	Verify diaphragm to wall connection before proceeding with any further advanced analysis for retrofit.

[1] We translate this Tier 1 evaluation to a Seismic Performance Level rating using professional judgment. Noncompliant items in the Tier 1 evaluation do not automatically put a building into a particular rating category, but we evaluate such items along with the combination of building features and potential deficiencies, focused on the potential for collapse or serious damage to the gravity supporting structure that may threaten occupant safety. See Section III B of the UC Seismic Policy and Method B of Section 321 of the 2016 California Existing Building Code.

[2] Per Section 3.A.4.i of the Seismic Program Guidebook, the cost includes all construction cost necessitated by the seismic retrofit, including restoration of finishes and any triggered work on utilities or accessibility. It does not include soft costs such as design fees or campus costs. The cost is in 2019 dollars.

Building information used in this evaluation

- Architectural drawings by Wurster, Bernardi and Emmons Architects, "Residential College Number One Unit 'B', University of California, Santa Cruz," as-built drawings dated December 12, 1966
- Structural drawings by Gilbert-Forsberg-Diekman-Schmidt Civil and Structural Engineers, as-built drawings dated December 12, 1966
- Site visit observations.

Additional building information known to exist

- None

Scope for completing this form

Reviewed structural drawings for original construction and carried out ASCE 41-17 Tier 1 evaluation. We made a site visit on June 5th, 2019. We looked for potentially hazardous nonstructural components during the site visit. No nonstructural hazards were identified.

Brief description of structure

The Cowell College Faculty Wing (CAAN 7133) is one of six buildings that were the Unit "B" cluster of the Residential College No. 1 (now known as Cowell College) at the University of California, Santa Cruz. The Cowell College Faculty Wing is the B6 building of the aforementioned cluster. The Cowell College Faculty Wing was built by the end of 1966.

The Cowell College Faculty Wing is a two story building with perimeter (exterior) concrete shear walls and plywood diaphragm at the second floor and pitched roof with interior stud walls. The walls are founded on strip footings tied together with a concrete slab-on-grade. There is a staircase at the northeast corner of the building. An elevator was added in the southeast corner of the building as part of the 1990 accessibility improvement project. The elevator is seismically separate from the original building. As shown in the 1966 as-built drawings, a concrete bridge connects the northwest end of the Cowell College Academic Building (CAAN 7130) to the south end of this building (CAAN 7133) at the second floor.

Identification of levels: First Floor, Second Floor, and Roof

Foundation system: Shallow foundation of strip footings

Structural system for vertical (gravity) load: Plywood sheathing diaphragm supported on wood framing at the pitched roof and second floor. At the roof, wood trusses span between the perimeter concrete shear walls, and at the second floor, wood joists span between the perimeter concrete shear walls.

Structural system for lateral forces: Plywood diaphragms at the roof and second floor levels to perimeter 8" thick concrete shear walls. All shear walls to strip footings tied together with 6" SOG.

Brief description of seismic deficiencies and expected seismic performance including mechanism of nonlinear response and structural behavior modes

The building has the following structural deficiencies per Tier 1 Quick checks for the Collapse Prevention performance objective at BSE-2E seismic event.

1. The out of plane wall anchorage is inadequate at the second floor diaphragm because the walls are anchored with a wood ledger, which will experience cross grain bending and there is no development of strength from the wall to the diaphragm via a member joist. Inadequate out of plane anchorage between the diaphragms and the concrete shear walls will cause separation of the building at the second floor diaphragm from the concrete walls and hence, loss of gravity support at the second floor diaphragm.
2. Diaphragms with large openings may not develop the shear strength to transfer load to the shear walls, which can result in unsupported shear walls. Again, there is a possibility of loss of gravity support at the second floor diaphragm near the stairs.

3. Discontinuous cross ties between diaphragm chords at the second and roof levels may lead to the diaphragm not developing the strength to resist demands from the out of plane walls. Lack of cross tie continuity may result in separation of the shear walls from the building.

4. The concrete bridge connecting this building (CAAN 7133) to the Cowell College Academic Building (CAAN 7130) may cause the collapse of the second floor diaphragm inside one of these buildings when the bridge is loaded in its longitudinal direction. Seismic forces in the longitudinal direction of this bridge will cause the bridge to pull the out-of-plane (diaphragm to wall) anchorage of one of these buildings and push on the other building's second floor diaphragm. The pulling at one of the diaphragms will cause the ledger connecting that diaphragm to the concrete shear wall to fail in cross-grain bending and may lead to the collapse of that diaphragm. It is important to note that both buildings have similar out-of-plane wall anchorage connections: anchors connecting the diaphragms to concrete shear walls with ledgers, which should be retrofitted to avoid the aforementioned cross-grain bending ledge failure.

Structural deficiency	Affects rating?	Structural deficiency	Affects rating?
Lateral system stress check (wall shear, column shear or flexure, or brace axial as applicable)	N	Openings at shear walls (concrete or masonry)	Y
Load path	N	Liquefaction	N
Adjacent buildings	N	Slope failure	N
Weak story	N	Surface fault rupture	N
Soft story	N	Masonry or concrete wall anchorage at flexible diaphragm	Y
Geometry (vertical irregularities)	N	URM wall height-to-thickness ratio	N
Torsion	N	URM parapets or cornices	N
Mass – vertical irregularity	N	URM chimney	N
Cripple walls	N	Heavy partitions braced by ceilings	N
Wood sills (bolting)	N	Appendages	N
Diaphragm continuity	N		

Summary of review of non-structural life-safety concerns, including at exit routes.[3]

No apparent nonstructural Life Safety concerns were spotted during site visit.

UCOP non-structural checklist item	Life safety hazard?	UCOP non-structural checklist item	Life safety hazard?
Heavy ceilings, feature or ornamentation above large lecture halls, auditoriums, lobbies or other areas where large numbers of people congregate	N	Unrestrained hazardous materials storage	N
Heavy masonry or stone veneer above exit ways and public access areas	N	Masonry chimneys	N
Unbraced masonry parapets, cornices or other ornamentation above exit ways and public access areas	N	Unrestrained natural gas-fueled equipment such as water heaters, boilers, emergency generators, etc.	N

Discussion of rating

The following noncompliances in the Tier 1 checklist form the basis of rating:

1. Inadequate out of plane wall anchorage: anchor bolts to ledgers at the second floor.

[3] For these Tier 1 evaluations, we do not visit all spaces of the building; we rely on campus staff to report to us their understanding of if and where non-structural hazards may occur.

2. Diaphragm opening sizes exceed 25% of concrete shear wall length at the second floor diaphragm due to stairs opening.

3. Discontinuous cross ties between diaphragm chords at the second and roof levels.

Recommendations for further evaluation or retrofit

A Tier 2 evaluation is recommended to evaluate existing connections and elements, such as the concrete bridge connection to the second floor diaphragm, and to determine better (lower) forces for retrofit design. It is recommended to expose the existing diaphragm to wall connections at the roof and second floor diaphragms to ensure compliance with as-built drawings before proceeding with any further advanced analysis for retrofit. If the existing connections are not compliant with as-built drawings, it is recommended to install hold downs at roof joists/trusses and second floor joists at 4'-0", epoxied into the existing concrete shear walls. This will remedy cross tie and inadequate out of plane wall anchorage issues. Other retrofit recommendations include installing straps or ties at the roof diaphragm to connect blocking to the top plate where existing anchors are located, and installing straps around the stairs opening, at the second floor, to strengthen the existing second floor diaphragm.

Peer review of rating

This seismic evaluation was discussed in a peer review meeting on June 19, 2019. Reviewers present were Bret Lizundia of R+C and Joe Maffei of Maffei Structural Engineering. Comments from the reviewers have been incorporated into and addressed in this report. The reviewers agreed with the assigned rating.

Additional building data	Entry	Notes
Latitude	36.9975	
Longitude	-122.053759	
Are there other structures besides this one under the same CAAN#	No	
Number of stories above lowest perimeter grade	2	
Number of stories (basements) below lowest perimeter grade	0	
Building occupiable area (OGSF)	4,161 sq. ft.	
Risk Category per 2016 CBC Table 1604.5	II	Faculty office occupancy.
Building structural height, h_n	17.2 ft	Structural height defined per ASCE 7-16 Section 11.2
Coefficient for period, C_t	0.020	Estimated using ASCE 41-17 equation 4-4 and 7-18
Coefficient for period, β	0.75	Estimated using ASCE 41-17 equation 4-4 and 7-18
Estimated fundamental period	0.169 sec	Estimated using ASCE 41-17 equation 4-4 and 7-18
Site data		
975 yr. hazard parameters S_s, S_1	1.287, 0.488	
Site class	D	
Site class basis	Geotech[4]	See footnote below
Site parameters F_a, F_v	1.2, 1.812	

[4] Determination of site class and assessment of geotechnical hazards are based on correspondence with Pacific Crest Geotechnical Engineers and Nolan, Zinn, and Associates Geologists. [*Revised Geology and Geologic Hazards, Santa Cruz Campus, University of California*, Job # 04003-SC 13 May 2005]. Site class is taken as D throughout the main campus of UC Santa Cruz. The following links provide hazard maps for liquefaction, landslide, and fault rupture:

Ground motion parameters S_{cs}, S_{c1}	1.545, 0.885	
S_a at building period	1.545	
Site V_{s30}	900 ft/s	
V_{s30} basis	Estimated	Estimated based on site classification of D.
Liquefaction potential	Low	
Liquefaction assessment basis	County Map	See footnote in previous page
Landslide potential	Low	
Landslide assessment basis	County map	See footnote in previous page
Active fault rupture identified at site?	No	
Fault rupture assessment basis	County map	See footnote in previous page
Site-specific ground motion study?	No	
Applicable code		
Applicable code or approx. date of original construction	Built: 1966 Code: 1964 UBC	Code inferred based on design year
Is this a benchmark building	No	
Is this a retrofit building?	No	
Applicable code for retrofit	N/A	
Model building data		
Model building type North-South	Concrete,C2a- Concrete Shear Walls (with Flexible Diaphragms)	
Model building type East-West	Concrete,C2a- Concrete Shear Walls (with Flexible Diaphragms)	
FEMA P-154 score	N/A	Not included here because we performed ASCE 41 Tier 1 evaluation.
Previous ratings		
Most recent rating	Unknown	
Date of most recent rating	Unknown	
2nd most recent rating	-	
Date of 2nd most recent rating	-	
3rd most recent rating	-	
Date of 3rd most recent rating	-	
Appendices		
ASCE 41 Tier 1 checklist included here?	Yes	Refer to attached checklist file in Appendix A.

https://gis.santacruzcounty.us/mapgallery/Emergency%20Management/Hazard%20Mitigation/LiquifactionMap2009.pdf
https://gis.santacruzcounty.us/mapgallery/Emergency%20Management/Hazard%20Mitigation/LandslideMap2009.pdf
https://gis.santacruzcounty.us/mapgallery/Emergency%20Management/Hazard%20Mitigation/FaultZoneMap2009.pdf

Appendix A
ASCE 41-17 Checklists

UC Campus:	Santa Cruz			Date:	6/20/19		
Building CAAN:	7133	Auxiliary CAAN:	-	By Firm:	Degenkolb Engineers		
Building Name:	Cowell College Faculty Wing			Initials:	PN	Checked:	
Building Address:	518 Cowell-Stevenson Road, Santa Cruz, CA 95064			Page:	1	of	3

ASCE 41-17
Collapse Prevention Basic Configuration Checklist

LOW SEISMICITY

BUILDING SYSTEMS - *GENERAL*

C	NC	N/A	U	Description
●	○	○	○	LOAD PATH: The structure contains a complete, well-defined load path, including structural elements and connections, that serves to transfer the inertial forces associated with the mass of all elements of the building to the foundation. (Commentary: Sec. A.2.1.1. Tier 2: Sec. 5.4.1.1) **Comments:**
○	○	○	●	ADJACENT BUILDINGS: The clear distance between the building being evaluated and any adjacent building is greater than 0.25% of the height of the shorter building in low seismicity, 0.5% in moderate seismicity, and 1.5% in high seismicity. (Commentary: Sec. A.2.1.2. Tier 2: Sec. 5.4.1.2) **Comments:** 1.5%(17.2') x 12"/ft = 3.1" < 16'-8"
○	○	●	○	MEZZANINES: Interior mezzanine levels are braced independently from the main structure or are anchored to the seismic-force-resisting elements of the main structure. (Commentary: Sec. A.2.1.3. Tier 2: Sec. 5.4.1.3) **Comments:**

BUILDING SYSTEMS - *BUILDING CONFIGURATION*

C	NC	N/A	U	Description
●	○	○	○	WEAK STORY: The sum of the shear strengths of the seismic-force-resisting system in any story in each direction is not less than 80% of the strength in the adjacent story above. (Commentary: Sec. A2.2.2. Tier 2: Sec. 5.4.2.1) **Comments:**
●	○	○	○	SOFT STORY: The stiffness of the seismic-force-resisting system in any story is not less than 70% of the seismic-force-resisting system stiffness in an adjacent story above or less than 80% of the average seismic-force-resisting system stiffness of the three stories above. (Commentary: Sec. A.2.2.3. Tier 2: Sec. 5.4.2.2) **Comments:**
●	○	○	○	VERTICAL IRREGULARITIES: All vertical elements in the seismic-force-resisting system are continuous to the foundation. (Commentary: Sec. A.2.2.4. Tier 2: Sec. 5.4.2.3) **Comments:**

Note: **C =** Compliant **NC =** Noncompliant **N/A =** Not Applicable **U =** Unknown

UC Campus:	Santa Cruz			Date:	6/20/19		
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ASCE 41-17
Collapse Prevention Basic Configuration Checklist

C	NC	N/A	U	
●	○	○	○	GEOMETRY: There are no changes in the net horizontal dimension of the seismic-force-resisting system of more than 30% in a story relative to adjacent stories, excluding one-story penthouses and mezzanines. (Commentary: Sec. A.2.2.5. Tier 2: Sec. 5.4.2.4) **Comments:**
●	○	○	○	MASS: There is no change in effective mass of more than 50% from one story to the next. Light roofs, penthouses, and mezzanines need not be considered. (Commentary: Sec. A.2.2.6. Tier 2: Sec. 5.4.2.5) **Comments:**
●	○	○	○	TORSION: The estimated distance between the story center of mass and the story center of rigidity is less than 20% of the building width in either plan dimension. (Commentary: Sec. A.2.2.7. Tier 2: Sec. 5.4.2.6) **Comments:** Symmetric building.

MODERATE SEISMICITY (COMPLETE THE FOLLOWING ITEMS IN ADDITION TO THE ITEMS FOR LOW SEISMICITY)

GEOLOGIC SITE HAZARD

C	NC	N/A	U	Description
●	○	○	○	LIQUEFACTION: Liquefaction-susceptible, saturated, loose granular soils that could jeopardize the building's seismic performance do not exist in the foundation soils at depths within 50 ft (15.2m) under the building. (Commentary: Sec. A.6.1.1. Tier 2: 5.4.3.1) **Comments:**
●	○	○	○	SLOPE FAILURE: The building site is located away from potential earthquake-induced slope failures or rockfalls so that it is unaffected by such failures or is capable of accommodating any predicted movements without failure. (Commentary: Sec. A.6.1.2. Tier 2: 5.4.3.1) **Comments:**
●	○	○	○	SURFACE FAULT RUPTURE: Surface fault rupture and surface displacement at the building site are not anticipated. (Commentary: Sec. A.6.1.3. Tier 2: 5.4.3.1) **Comments:**

Note: **C =** Compliant **NC =** Noncompliant **N/A =** Not Applicable **U =** Unknown

UC Campus:	Santa Cruz			Date:	6/20/19		
Building CAAN:	7133	Auxiliary CAAN:	-	By Firm:	Degenkolb Engineers		
Building Name:	Cowell College Faculty Wing			Initials:	*PN*	Checked:	
Building Address:	518 Cowell-Stevenson Road, Santa Cruz, CA 95064			Page:	3	of	3

ASCE 41-17
Collapse Prevention Basic Configuration Checklist

HIGH SEISMICITY (COMPLETE THE FOLLOWING ITEMS IN ADDITION TO THE ITEMS FOR MODERATE SEISMICITY)

FOUNDATION CONFIGURATION

	Description
C ◉ NC ○ N/A ○ U ○	OVERTURNING: The ratio of the least horizontal dimension of the seismic-force-resisting system at the foundation level to the building height (base/height) is greater than $0.6S_a$. (Commentary: Sec. A.6.2.1. Tier 2: Sec. 5.4.3.3) **Comments:** 30.6'/17.2' = 1.78 0.6*1.545 = 0.927 < 1.78 (OK)
C ◉ NC ○ N/A ○ U ○	TIES BETWEEN FOUNDATION ELEMENTS: The foundation has ties adequate to resist seismic forces where footings, piles, and piers are not restrained by beams, slabs, or soils classified as Site Class A, B, or C. (Commentary: Sec. A.6.2.2. Tier 2: Sec. 5.4.3.4) **Comments:** Slab on grade tie spread footings together.

Note: **C =** Compliant **NC =** Noncompliant **N/A =** Not Applicable **U =** Unknown

UC Campus:	Santa Cruz			Date:	6/20/19		
Building CAAN:	7133	Auxiliary CAAN:	-	By Firm:	Degenkolb Engineers		
Building Name:	Cowell College Faculty Wing			Initials:	PN	Checked:	
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ASCE 41-17
Collapse Prevention Structural Checklist For Building Type C2-C2A

Low And Moderate Seismicity

Seismic-Force-Resisting System

	Description
C ○ NC ○ N/A ◉ U ○	COMPLETE FRAMES: Steel or concrete frames classified as secondary components form a complete vertical-load-carrying system. (Commentary: Sec. A.3.1.6.1. Tier 2: Sec. 5.5.2.5.1) **Comments:**
C ◉ NC ○ N/A ○ U ○	REDUNDANCY: The number of lines of shear walls in each principal direction is greater than or equal to 2. (Commentary: Sec. A.3.2.1.1. Tier 2: Sec. 5.5.1.1) **Comments:** Two lines of shear walls in both directions
C ◉ NC ○ N/A ○ U ○	SHEAR STRESS CHECK: The shear stress in the concrete shear walls, calculated using the Quick Check procedure of Section 4.4.3.3, is less than the greater of 100 lb/in.^{2} (0.69 MPa) or $2\sqrt{f'_c}$. (Commentary: Sec. A.3.2.2.1. Tier 2: Sec. 5.5.3.1.1) **Comments:** See quick checks. DCR < 1 (OK)
C ◉ NC ○ N/A ○ U ○	REINFORCING STEEL: The ratio of reinforcing steel area to gross concrete area is not less than 0.0012 in the vertical direction and 0.0020 in the horizontal direction. (Commentary: Sec. A.3.2.2.2. Tier 2: Sec. 5.5.3.1.3) **Comments:** See quick checks

Connections

	Description
C ○ NC ◉ N/A ○ U ○	WALL ANCHORAGE AT FLEXIBLE DIAPHRAGMS: Exterior concrete or masonry walls that are dependent on flexible diaphragms for lateral support are anchored for out-of-plane forces at each diaphragm level with steel anchors, reinforcing dowels, or straps that are developed into the diaphragm. Connections have strength to resist the connection force calculated in the Quick Check procedure of Section 4.4.3.7. (Commentary: Sec. A.5.1.1. Tier 2: Sec. 5.7.1.1) **Comments:** Although DCR < 1 per quick checks, anchorage is inadequate at the second floor diaphragm because the walls are anchored with a wood ledger, which will experience cross grain bending and there is no development of strength from the wall to the diaphragm via a member joist. Refer to details 1/S14, 8/S14, and 11/S14.
C ◉ NC ○ N/A ○ U ○	TRANSFER TO SHEAR WALLS: Diaphragms are connected for transfer of seismic forces to the shear walls. (Commentary: Sec. A.5.2.1. Tier 2: Sec. 5.7.2) **Comments:**

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ASCE 41-17
Collapse Prevention Structural Checklist For Building Type C2-C2A

C	NC	N/A	U	
◉	○	○	○	FOUNDATION DOWELS: Wall reinforcement is doweled into the foundation with vertical bars equal in size and spacing to the vertical wall reinforcing directly above the foundation. (Commentary: Sec. A.5.3.5. Tier 2: Sec. 5.7.3.4) **Comments:**

High Seismicity (Complete The Following Items In Addition To The Items For Low And Moderate Seismicity)

Seismic-Force-Resisting System

				Description
C	NC	N/A	U	
○	○	◉	○	DEFLECTION COMPATIBILITY: Secondary components have the shear capacity to develop the flexural strength of the components. (Commentary: Sec. A.3.1.6.2. Tier 2: Sec. 5.5.2.5.2) **Comments:**
○	○	◉	○	FLAT SLABS: Flat slabs or plates not part of the seismic-force-resisting system have continuous bottom steel through the column joints. (Commentary: Sec. A.3.1.6.3. Tier 2: Sec. 5.5.2.5.3) **Comments:**
○	○	◉	○	COUPLING BEAMS: The ends of both walls to which the coupling beam is attached are supported at each end to resist vertical loads caused by overturning. (Commentary: Sec. A.3.2.2.3. Tier 2: Sec. 5.5.3.2.1) **Comments:** No coupling beams are present

Diaphragms (Stiff Or Flexible)

				Description
C	NC	N/A	U	
◉	○	○	○	DIAPHRAGM CONTINUITY: The diaphragms are not composed of split-level floors and do not have expansion joints. (Commentary: Sec. A.4.1.1. Tier 2: Sec. 5.6.1.1) **Comments:** No split level diaphragms
○	◉	○	○	OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls are less than 25% of the wall length. (Commentary: Sec. A.4.1.4. Tier 2: Sec. 5.6.1.3) **Comments:** 10'-4.5" / 64'-1" = 16.2% < 25 % in North-South direction of 2nd floor diaphragm (OK) 10'-1.5" / 30'-7" = 33.1% > 25% in East-West direction of 2nd floor diaphragm (NG)

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ASCE 41-17
Collapse Prevention Structural Checklist For Building Type C2-C2A

Flexible Diaphragms

C	NC	N/A	U	Description
○	●	○	○	CROSS TIES: There are continuous cross ties between diaphragm chords. (Commentary: Sec. A.4.1.2. Tier 2: Sec. 5.6.1.2) **Comments:** Cross ties are not continuous.
○	○	●	○	STRAIGHT SHEATHING: All straight-sheathed diaphragms have aspect ratios less than 2-to-1 in the direction being considered. (Commentary: Sec. A.4.2.1. Tier 2: Sec. 5.6.2) **Comments:** Plywood sheathed diaphragm
●	○	○	○	SPANS: All wood diaphragms with spans greater than 24 ft (7.3 m) consist of wood structural panels or diagonal sheathing. (Commentary: Sec. A.4.2.2. Tier 2: Sec. 5.6.2) **Comments:** Plywood sheathed diaphragm
●	○	○	○	DIAGONALLY SHEATHED AND UNBLOCKED DIAPHRAGMS: All diagonally sheathed or unblocked wood structural panel diaphragms have horizontal spans less than 40 ft (12.2 m) and aspect ratios less than or equal to 4-to-1. (Commentary: Sec. A.4.2.3. Tier 2: Sec. 5.6.2) **Comments:** Aspect ratio = 64.1' / 30.6' = 2.1 < 4 (OK) L = max(30.6', 64.1' – (9'x2 + 10.4') = max(30.6', 35.7') = 35.7' < 40' (OK)
●	○	○	○	OTHER DIAPHRAGMS: Diaphragms do not consist of a system other than wood, metal deck, concrete, or horizontal bracing. (Commentary: Sec. A.4.7.1. Tier 2: Sec. 5.6.5) **Comments:**

Connections

C	NC	N/A	U	Description
○	○	●	○	UPLIFT AT PILE CAPS: Pile caps have top reinforcement, and piles are anchored to the pile caps. (Commentary: Sec. A.5.3.8. Tier 2: Sec. 5.7.3.5) **Comments:** Spread and strip footings utilized.

Appendix B
Quick Check Calculations

Subject:	Global Data	**Job Number:**	B9959006.00	**Date:**	06/10/19
Job:	UCSC Tier 1 Seismic Evaluations	**By:**	PN	**Section:**	
	CAAN 7133	**Checked By:**		**Page**	

GLOBAL DATA

ASCE 41-17 SEISMIC EVALUATION & RETROFIT OF EXISTING BUILDINGS
CHAPTER 4 - TIER 1 EVALUATION
LINEAR STATIC PROCEDURE
COLLAPSE PREVENTION
BSE-2E HAZARD LEVEL

SITE DATA:

Latitude:		36.99735	°N	518 Cowell-Stevenson Road	*USGS Seismic Design Map Application:*	
Longitude:		122.05344	°W	Santa Cruz, CA 95064	*http://geohazards.usgs.gov/hazardtool/application.php*	
Site Class:		D (default)		(Stiff Soil)	Site Class	[ASCE 41-17, §2.4.1.6]
S_S	=	1.287	g	(USGS) (5% / 50 years)	USGS Mapped (T = 0.2 sec)	[ASCE 41-17, §2.4.1.3]
S_1	=	0.488	g	(USGS) (5% / 50 years)	USGS Mapped (T = 1.0 sec)	[ASCE 41-17, §2.4.1.3]
F_a	=	1.200		(Site Class D)	Site Coefficient (T = 0.2 sec)	[ASCE 7-16, Table 11.4-1]
F_v	=	1.812		(Site Class D)	Site Coefficient (T = 1.0 sec)	[ASCE 7-16, Table 11.4-2]
S_{XS}	=	1.545	g	= F_a S_S	Site-Adjusted Design (T = 0.2 sec)	[ASCE 41-17, Eq. 2-1]
S_{X1}	=	0.885	g	= F_v S_1	Site-Adjusted Design (T = 1.0 sec)	[ASCE 41-17, Eq. 2-2]

BUILDING DATA:

Building Type:	C2A	(Concrete Shear Walls with Flexible Diaphragms)	[ASCE 41-17, Table 3-1]
Year Built:	1966		
Number of Stories:	2	stories	
Parapet Height:	0.00	ft	
Roof Height:	17.17	ft	
Total Area:	3,920	sf	

Level	Height [ft]	Elevation [ft]	$Length_{N-S}$ [ft]	$Length_{E-W}$ [ft]	Area [sf]	Diaphragm Stiffness	Diaphragm Description
Roof	8.1	17.2	64	31	1,960	Flexible	Plywood Sheathing
2nd	9.1	9.1	64	31	1,960	Flexible	Plywood Sheathing
1st	0.0	0.0	64	31	1,960	-	-

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ROOF TYPE: ROOF

		Roofing / Re-roofing		@	5.0 psf	0.0 psf	n
0.5	in	Rock Ballast (Gravel)		@	8.0 psf per inch	0.0 psf	n
3	ply	Ready Roofing		@	0.3 psf per ply	0.0 psf	n
5	ply	Felt Roofing		@	0.5 psf per ply	0.0 psf	n
0.25	in	Slate		@	40.0 psf per inch	0.0 psf	n
		Shingles	(Asphalt)	@	2.0 psf	0.0 psf	n
		Copper or Tin		@	1.0 psf	0.0 psf	n
		Corrugated Asbestos-Cement		@	4.0 psf	0.0 psf	n
		Waterproofing Membranes	(Smooth Bituminous)	@	1.5 psf	0.0 psf	n
		Cement Tiles		@	16.0 psf	0.0 psf	n
		Clay Tiles	(Roman)	@	12.0 psf	12.0 psf	y
		Mortar Bed for Clay Tiles		@	10.0 psf	10.0 psf	y
		Roof Insulation		@	1.0 psf	0.0 psf	n
1	in	Insulation	(Rigid)	@	1.5 psf per inch	1.5 psf	y
1	in	Insulation Boards	(Fibrous Glass)	@	1.1 psf per inch	0.0 psf	n
3	in	Vermiculite Concrete		@	2.5 psf per inch	0.0 psf	n
0.5	in	Fire Proofing		@	2.0 psf per inch	0.0 psf	n
		Diaphragm - core planks		@	35.0 psf	0.0 psf	n
2.5	in	Concrete Slab	(Normal Weight)	@	12.5 psf per inch	0.0 psf	n
4.75	in	Concrete Fill	(Light Weight)	@	9.2 psf per inch	0.0 psf	n
0.5	in	Concrete Overpour	(Light Weight)	@	9.2 psf per inch	0.0 psf	n
18	ga	Bare Metal Deck		@	3.0 psf	0.0 psf	n
2	in	Wood Decking		@	2.5 psf per inch	0.0 psf	n
2	in	Wood Sheathing		@	3.0 psf per inch	0.0 psf	n
0.625	in	Plywood		@	3.2 psf per inch	2.0 psf	y
		Framing		@	20.0 psf	0.0 psf	n
6	ft O.C.	Steel Beams		@	22.0 plf	0.0 psf	n
36	ft O.C.	Steel Girders		@	76.0 plf	0.0 psf	n
2	ft O.C.	Wood Sub-Purlins		@	1.8 plf	0.0 psf	n
2.00	ft O.C.	Wood Purlins		@	4.5 plf	2.2 psf	y
8	ft O.C.	Wood Girders		@	20.1 plf	2.5 psf	y
12.75	ft O.C.	Concrete Beams		@	800.0 plf	0.0 psf	n
20	ft O.C.	Concrete Girders		@	300.0 plf	0.0 psf	n
4.04	ft trib. ht.	Typical Columns	(A_{trib} = 82 sf)	@	128.4 plf	0.0 psf	n
		Ceiling		@	5.0 psf	5.0 psf	y
0.5	in	Gypsum Board Ceiling		@	4.4 psf per inch	0.0 psf	n
		Acoustical Fiber Board		@	1.0 psf	0.0 psf	n
		Plaster Ceiling	(On Tile)	@	5.0 psf	0.0 psf	n
		Suspended Metal Lath & Plaster	(Gypsum Plaster)	@	10.0 psf	0.0 psf	n
		Suspended Steel Channel System		@	2.0 psf	0.0 psf	n
		Suspended Wood Furring System		@	2.5 psf	0.0 psf	n
		T-bar Ceiling System		@	3.0 psf	0.0 psf	n
50%	floor area	Interior Partitions	(Below)	@	5.0 psf	2.5 psf	y
		M.E.P.		@	5.0 psf	5.0 psf	y
		Miscellaneous		@	1.3 psf	1.3 psf	y
		Percast Fascia (4sqft)		@	47.1 psf	0.0 psf	n
		Other		@	1.0 psf	0.0 psf	n
		Other		@	1.0 psf	0.0 psf	n
		Other		@	1.0 psf	0.0 psf	n
		Other		@	1.0 psf	0.0 psf	n
					ROOF WEIGHT =	**44.0 psf**	

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FLOOR TYPE: FLR-2

		Flooring		@	15.0 psf	0.0 psf	n
1	in	Floor Tiles	(Linoleum Tile)	@	4.0 psf per inch	4.0 psf	y
0.75	in	Wood Flooring	(Hardwood)	@	4.6 psf per inch	0.0 psf	n
2	in	Wood Blocks		@	3.3 psf per inch	0.0 psf	n
2	in	Asphalt Blocks		@	12.0 psf per inch	0.0 psf	n
0.75	in	Mastic		@	12.0 psf per inch	0.0 psf	n
1	in	Cement Finish		@	12.0 psf per inch	0.0 psf	n
2	in	Mortar Bed		@	12.0 psf per inch	0.0 psf	n
2	in	Floor Fill	(Stone Concrete)	@	12.0 psf per inch	0.0 psf	n
0.75	in	Subflooring		@	4.0 psf per inch	0.0 psf	n
		Marble & Mortar, Stone Concrete		@	33.0 psf	0.0 psf	n
		Solid Flat Tile, 1-in Mortar Base		@	23.0 psf	0.0 psf	n
		Floor Insulation		@	1.0 psf	0.0 psf	n
1	in	Insulation	(Rigid)	@	1.5 psf per inch	1.5 psf	y
1	in	Insulation Boards	(Fibrous Glass)	@	1.1 psf per inch	0.0 psf	n
3	in	Vermiculite Concrete		@	2.5 psf per inch	0.0 psf	n
0.5	in	Fire Proofing		@	2 psf per inch	0.0 psf	n
		Diaphragm		@	20.0 psf	0.0 psf	n
1.625	in	Concrete Slab	(Normal Weight)	@	12.5 psf per inch	0.0 psf	n
1.63	in	Concrete Fill	(Light Weight)	@	9.2 psf per inch	14.9 psf	y
0.5	in	Concrete Overpour	(Light Weight)	@	9.2 psf per inch	0.0 psf	n
18	ga	Bare Metal Deck		@	3.0 psf	0.0 psf	n
2	in	Wood Decking		@	2.5 psf per inch	0.0 psf	n
2	in	Wood Sheathing		@	3.0 psf per inch	0.0 psf	n
0.625	in	Plywood		@	3.2 psf per inch	2.0 psf	y
		Framing		@	20.0 psf	0.0 psf	n
6	ft O.C.	Steel Beams		@	22.0 plf	0.0 psf	n
36	ft O.C.	Steel Girders		@	76.0 plf	0.0 psf	n
2	ft O.C.	Wood Sub-Purlins		@	1.8 plf	0.0 psf	n
1.33	ft O.C.	Wood Purlins		@	3.1 plf	2.3 psf	y
8.00	ft O.C.	Wood Girders		@	5.0 plf	0.0 psf	n
8	ft O.C.	Concrete Beams		@	200.0 plf	0.0 psf	n
20	ft O.C.	Concrete Girders		@	300.0 plf	0.0 psf	n
8.6	ft trib. ht.	Typical Columns	(A_{trib} = 140 sf)	@	5.7 plf	0.3 psf	y
		Ceiling		@	5.0 psf	5.0 psf	y
0.5	in	Gypsum Board Ceiling		@	4.4 psf per inch	0.0 psf	n
		Acoustical Fiber Board		@	1.0 psf	0.0 psf	n
		Plaster Ceiling	(On Tile)	@	5.0 psf	0.0 psf	n
		Suspended Metal Lath & Plaster	(Gypsum Plaster)	@	10.0 psf	0.0 psf	n
		Suspended Steel Channel System		@	2.0 psf	0.0 psf	n
		Suspended Wood Furring System		@	2.5 psf	0.0 psf	n
		T-bar Ceiling System		@	3.0 psf	0.0 psf	n
50%	floor area	Interior Partitions	(Above & Below)	@	10.0 psf	5.0 psf	y
		M.E.P.		@	5.0 psf	5.0 psf	y
		Miscellaneous		@	1.9 psf	1.9 psf	y
		Other		@	1.0 psf	0.0 psf	n
		Other		@	1.0 psf	0.0 psf	n
		Other		@	1.0 psf	0.0 psf	n
		Other		@	1.0 psf	0.0 psf	n
		Other		@	1.0 psf	0.0 psf	n

FLR-2 WEIGHT = 42.0 psf

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WALL TYPE: WALL-P

		Wall Covering		@	4.0	psf	4.0 psf	y
1	in	Exterior Stucco		@	11.4	psf per inch.	11.4 psf	y
1	in	Wood Sheathing		@	3.0	psf per inch	0.0 psf	n
0.5	in	Gypsum Sheathing		@	4.0	psf per inch	0.0 psf	n
0.5	in	Gypsum Wallboard		@	4.4	psf per inch	0.0 psf	n
		Porcelain Enamel Panels		@	5.0	psf	0.0 psf	n
		Metal Lath & Plaster	(Gypsum Plaster)	@	10.0	psf	0.0 psf	n
		Wall Insulation		@	1.0	psf	1.0 psf	y
1	in	Insulation	(Rigid)	@	1.5	psf per inch	0.0 psf	n
1	in	Insulation Boards	(Fiber Board)	@	1.5	psf per inch	0.0 psf	n
0.5	in	Fire Proofing		@	2	psf per inch	0.0 psf	n
		Wall Framing		@	20.0	psf	20.0 psf	y
8	in	Concrete Wall	(Normal Weight)	@	12.5	psf per inch	0.0 psf	n
8	in	CMU Wall w/ Full Grouting	(Normal Weight)	@	83.0	psf	0.0 psf	n
8	in	Solid CMU Wall	(Normal Weight)	@	87.0	psf	0.0 psf	n
4	in	HCB Wall w/ Full Grouting		@	38.0	psf	0.0 psf	n
3.5	in	Solid Clay Brick Wall		@	11.1	psf per inch	0.0 psf	n
0.5	in	Plywood		@	3.2	psf per inch	0.0 psf	n
16	in O.C.	Wood Studs	(2 x 4)	@	1.1	plf	0.0 psf	n
16	in O.C.	Metal Channel Studs		@	2.0	plf	0.0 psf	n
8	ft O.C.	Steel Girts		@	6.0	plf	0.0 psf	n
		Miscellaneous		@	1.6	psf	1.6 psf	y
		Other		@	1.0	psf	0.0 psf	n
		Other		@	1.0	psf	0.0 psf	n
		Other		@	1.0	psf	0.0 psf	n
		Other		@	1.0	psf	0.0 psf	n
		Other		@	1.0	psf	0.0 psf	n

Solid Wall Weight =	38.0	psf
Window & Door Weight =	8.0	psf
% Solid Wall =	100%	
WALL-P WEIGHT =	**38.0**	**psf**

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BSE-2E HAZARD LEVEL

WALL TYPE: WALL-R

		Wall Covering		@	4.0	psf	4.0 psf	y
1	in	Exterior Stucco		@	11.4	psf per inch.	0.0 psf	n
1	in	Wood Sheathing		@	3.0	psf per inch	0.0 psf	n
0.5	in	Gypsum Sheathing		@	4.0	psf per inch	0.0 psf	n
0.5	in	Gypsum Wallboard		@	4.4	psf per inch	0.0 psf	n
		Porcelain Enamel Panels		@	5.0	psf	0.0 psf	n
		Metal Lath & Plaster	(Gypsum Plaster)	@	10.0	psf	0.0 psf	n
		Wall Insulation		@	1.0	psf	1.0 psf	y
1	in	Insulation	(Rigid)	@	1.5	psf per inch	0.0 psf	n
1	in	Insulation Boards	(Fiber Board)	@	1.5	psf per inch	0.0 psf	n
0.5	in	Fire Proofing		@	2	psf per inch	0.0 psf	n
		Wall Framing		@	20.0	psf	0.0 psf	n
8	in	Concrete Wall	(Normal Weight)	@	12.5	psf per inch	100.0 psf	y
8	in	CMU Wall w/ Full Grouting	(Normal Weight)	@	83.0	psf	0.0 psf	n
8	in	Solid CMU Wall	(Normal Weight)	@	87.0	psf	0.0 psf	n
4	in	HCB Wall w/ Full Grouting		@	38.0	psf	0.0 psf	n
3.5	in	Solid Clay Brick Wall		@	11.1	psf per inch	0.0 psf	n
0.5	in	Plywood		@	3.2	psf per inch	0.0 psf	n
16	in O.C.	Wood Studs	(2 x 4)	@	1.1	plf	0.0 psf	n
16	in O.C.	Metal Channel Studs		@	2.0	plf	0.0 psf	n
8	ft O.C.	Steel Girts		@	6.0	plf	0.0 psf	n
		Miscellaneous		@	1.0	psf	1.0 psf	y
		Other		@	1.0	psf	0.0 psf	n
		Other		@	1.0	psf	0.0 psf	n
		Other		@	1.0	psf	0.0 psf	n
		Other		@	1.0	psf	0.0 psf	n
		Other		@	1.0	psf	0.0 psf	n

Solid Wall Weight =	106.0	psf
Window & Door Weight =	8.0	psf
% Solid Wall =	70%	
WALL-R WEIGHT =	**76.6**	**psf**

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WALL TYPE: WALL-2

		Wall Covering		@	4.0	psf	4.0 psf	y
1	in	Exterior Stucco		@	11.4	psf per inch.	0.0 psf	n
1	in	Wood Sheathing		@	3.0	psf per inch	0.0 psf	n
0.5	in	Gypsum Sheathing		@	4.0	psf per inch	0.0 psf	n
0.5	in	Gypsum Wallboard		@	4.4	psf per inch	0.0 psf	n
		Porcelain Enamel Panels		@	5.0	psf	0.0 psf	n
		Metal Lath & Plaster	(Gypsum Plaster)	@	10.0	psf	0.0 psf	n
		Wall Insulation		@	1.0	psf	1.0 psf	y
1	in	Insulation	(Rigid)	@	1.5	psf per inch	0.0 psf	n
1	in	Insulation Boards	(Fiber Board)	@	1.5	psf per inch	0.0 psf	n
0.5	in	Fire Proofing		@	2	psf per inch	0.0 psf	n
		Wall Framing		@	20.0	psf	0.0 psf	n
8	in	Concrete Wall	(Normal Weight)	@	12.5	psf per inch	100.0 psf	y
8	in	CMU Wall w/ Full Grouting	(Normal Weight)	@	83.0	psf	0.0 psf	n
8	in	Solid CMU Wall	(Normal Weight)	@	87.0	psf	0.0 psf	n
4	in	HCB Wall w/ Full Grouting		@	38.0	psf	0.0 psf	n
3.5	in	Clay Brick Wall		@	11.1	psf per inch	0.0 psf	n
0.5	in	Plywood		@	3.2	psf per inch	0.0 psf	n
16	in O.C.	Wood Studs	(2 x 4)	@	1.1	plf	0.0 psf	n
16	in O.C.	Metal Channel Studs		@	2.0	plf	0.0 psf	n
8	ft O.C.	Steel Girts		@	6.0	plf	0.0 psf	n
		Miscellaneous		@	1.0	psf	1.0 psf	y
		Other		@	1.0	psf	0.0 psf	n
		Other		@	1.0	psf	0.0 psf	n
		Other		@	1.0	psf	0.0 psf	n
		Other		@	1.0	psf	0.0 psf	n
		Other		@	1.0	psf	0.0 psf	n

Solid Wall Weight =	106.0	psf
Window & Door Weight =	8.0	psf
% Solid Wall =	70%	
WALL-2 WEIGHT =	**76.6**	**psf**

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SEISMIC MASS

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BSE-2E HAZARD LEVEL

ROOF/FLOOR WEIGHT SUMMARY:

Level Type	Weight [psf]
ROOF	44
FLR-2	42

WALL WEIGHT SUMMARY:

Wall Type	Weight [psf]		
	Net	Solid	Openings
WALL-R	76.6	106	8
WALL-2	76.6	106	8

SEISMIC MASS SUMMARY:

Level	FLOOR			WALL ABOVE				WALL BELOW				TOTAL
	Level Type	Weight [psf]	Area [sf]	Wall Type	Weight [psf]	Length [ft]	Height [ft]	Wall Type	Weight [psf]	Length [ft]	Height [ft]	WEIGHT [kips]
Roof	ROOF	44	1,960	WALL-R	76.6	0	0.00	WALL-R	76.6	189	4.04	145
2nd	FLR-2	42	1,960	WALL-2	76.6	189	4.04	WALL-2	76.6	189	4.54	207
											TOTAL	352

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SEISMIC FORCES

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BUILDING TYPE: C2A (Concrete Shear Walls with Flexible Diaphragms) [ASCE 41-17, Table 3-1]
SITE CLASS: D (default) #N/A [ASCE 41-17, §2.4.1.6]

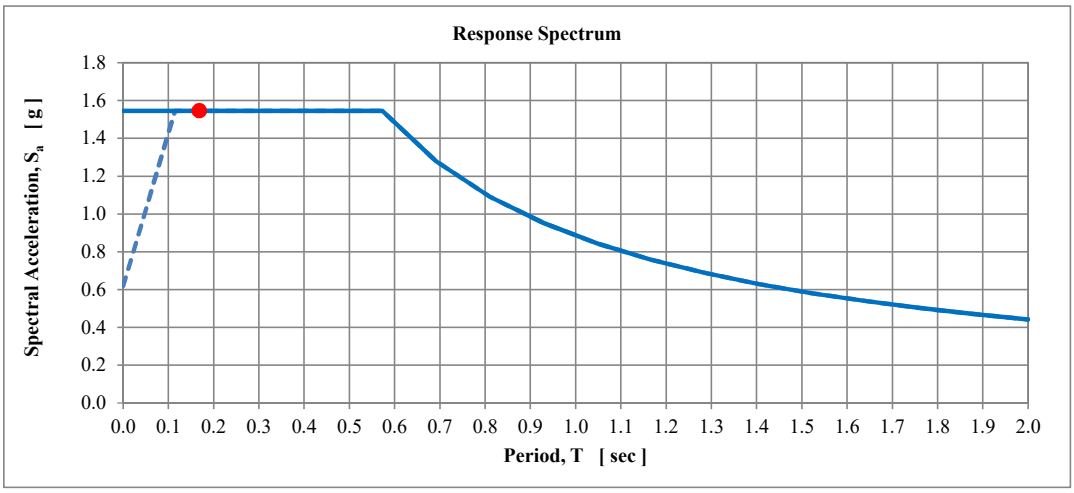
DESIGN SPECTRAL ACCELERATIONS:

S_{XS}	=	1.545 g	(BSE-2E)	Site-Adjusted Design (T = 0.2 sec)	[ASCE 41-17, Eq. 2-1]
S_{X1}	=	0.885 g	(BSE-2E)	Site-Adjusted Design (T = 1.0 sec)	[ASCE 41-17, Eq. 2-2]

BUILDING PERIOD:

h_n	=	17.2 ft	(Base to Roof)	Building Height	[ASCE 41-17, §4.4.2.4]
C_t	=	0.020	(Building Type C2A)	Period Coefficient	[ASCE 41-17, §4.4.2.4]
β	=	0.750	(Building Type C2A)	Period Exponent	[ASCE 41-17, §4.4.2.4]
T	=	0.169 sec	$= C_t h_n^{\beta}$	Fundamental Period	[ASCE 41-17, Eq. 4-4]

RESPONSE SPECTRUM:



PSEUDO LATERAL FORCE:

n	=	2	(n = 2)	Total Number of Stories	
C	=	1.0	(Building Type C2A)	Modification Factor	[ASCE 41-17, Table 4-7]
S_a	=	1.545 g	$= MIN \{ S_{X1} / T , S_{XS} \}$	Spectral Acceleration	[ASCE 41-17, Eq. 4-3]
V	**=**	**1.545 W**	$= C S_a W$	Pseudo Lateral Force	[ASCE 41-17, Eq. 4-1]

VERTICAL DISTRIBUTION OF SEISMIC FORCES:

k = 1.00 (T ≤ 0.5 sec) Seismic Distribution Exponent [ASCE 41-17, §4.4.2.2]

$F_x = C_{vx} V = [w_x h_x^k / \Sigma (w_x h_x^k)] V$ [ASCE 41-17, Eq. 4-2a]

$V_j = \Sigma F_x$ [ASCE 41-17, Eq. 4-2b]

Level	h_x [ft]	w_x [kips]	$w_x h_x^k$	C_{vx}	F_x [kips]	V_j [kips]
Roof	17.2	145	2,487	0.57	309	309
2nd	9.1	207	1,878	0.43	234	543
TOTAL	-	352	4,365	1.00	543	-

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QUICK CHECKS

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LINEAR STATIC PROCEDURE
COLLAPSE PREVENTION
BSE-2E HAZARD LEVEL

BUILDING TYPE: C2A (Concrete Shear Walls with Flexible Diaphragms) [ASCE 41-17, Table 3-1]

STEEL REINFORCING RATIO CHECK: [ASCE 41-17, §A.3.2.2.2]

		Horizontal Reinforcing					Vertical Reinforcing				
Wall Type	t_w [in]	$n_{curtains}$ [curtains]	Bar Size No.	Spacing [in]	ρ_h	$\rho_h \geq 0.0020$	$n_{curtains}$ [curtains]	Bar Size No.	Spacing [in]	ρ_v	$\rho_v \geq 0.0012$
WALL-R	8	2	4	18	0.0028	OK	2	3	12	0.0023	OK
WALL-2	8	2	4	18	0.0028	OK	2	3	12	0.0023	OK

AVERAGE SHEAR STRESS CHECK: [ASCE 41-17, §A.3.2.2.1]

f'_c	=	3,000 psi	(Specified)	Concrete Compressive Strength	[ASCE 41-17, §4.2.3]
v_n	=	110 psi	= MAX { 100 psi , 2 $\sqrt{f'_c}$ }	Shear Wall Capacity	[ASCE 41-17, §A.3.2.2.1]
M_s	=	4.5	COLLAPSE PREVENTION	System Modification Factor	[ASCE 41-17, Table 4-8]
$v_{j,\,avg}$	=	(1 / M_s) (V_j / A_w)		Average Shear Wall Stress	[ASCE 41-17, Eq. 4-8]
A_w	=	t_w ($L_{w,\,total}$ - $L_{w,\,openings}$)		Net Wall Area	[ASCE 41-17, §4.4.3.3]

North-South Direction:

Level	V_j [kips]	Wall Type	t_w [in]	$L_{w,\,total}$ [ft]	$L_{w,\,openings}$ [ft]	L_w [ft]	A_w [in^2]	$v_{j,\,avg}$ [psi]	DCR	Quick Check
Roof	309	WALL-R	8	128	57	71	6,832	10	0.09	OK
2nd	543	WALL-2	8	128	57	71	6,832	18	0.16	OK

East-West Direction:

Level	V_j [kips]	Wall Type	t_w [in]	$L_{w,\,total}$ [ft]	$L_{w,\,openings}$ [ft]	L_w [ft]	A_w [in^2]	$v_{j,\,avg}$ [psi]	DCR	Quick Check
Roof	309	WALL-R	8	61	10	52	4,960	14	0.13	OK
2nd	543	WALL-2	8	61	10	52	4,960	24	0.22	OK

Subject:	Quick Checks	**Job Number:**	B9959006.00	**Date:**	06/10/19
Job:	UCSC Tier 1 Seismic Evaluations	**By:**	PN	**Section:**	
		Checked By:		**Page**	

QUICK CHECKS

ASCE 41-17 SEISMIC EVALUATION & RETROFIT OF EXISTING BUILDINGS
CHAPTER 4 - TIER 1 EVALUATION
LINEAR STATIC PROCEDURE
COLLAPSE PREVENTION
BSE-2E HAZARD LEVEL

BUILDING TYPE: C2A (Concrete Shear Walls with Flexible Diaphragms) [ASCE 41-17, Table 3-1]

OUT-OF-PLANE WALL ANCHORAGE CHECK: [ASCE 41-17, §A.5.1.1]

Ψ	=	1.0	COLLAPSE PREVENTION	Out-of-Plane Wall Anchorage Coefficient	[ASCE 41-17, §4.4.3.7]
S_{XS}	=	1.545 g	(BSE-2E)	Design Spectral Acceleration (T = 0.2 sec)	[ASCE 41-17, §2.4.1.1]
T_c	=	$\Psi\ S_{XS}\ w_p\ A_p$		Out-of-Plane Wall Anchorage Force	[ASCE 41-17, Eq. 4-12]
$w_p\ A_p$	=	$(w_{w,\,above}\ h_{w,\,above} + w_{w,\,below}\ h_{w,\,below})\ s_{anchor}$		Tributary Mass to Anchorage	[ASCE 41-17, §4.4.3.7]

North-South Direction:

Level	WALL ABOVE			WALL BELOW			OUT-OF-PLANE ANCHORAGE					
	Wall Type	Weight [psf]	Height [ft]	Wall Type	Weight [psf]	Height [ft]	s_{anchor} [ft]	$w_p\ A_p$ [lb]	T_c [lb]	T_{cn} [lb]	DCR	Quick Check
Roof	WALL-P	38	0.00	WALL-R	106	4.04	4.00	1,714	2,647	7,555	0.35	OK
2nd	WALL-R	106	4.04	WALL-2	106	4.54	2.67	2,426	3,748	5,521	0.68	OK

East-West Direction:

Level	WALL ABOVE			WALL BELOW			OUT-OF-PLANE ANCHORAGE					
	Wall Type	Weight [psf]	Height [ft]	Wall Type	Weight [psf]	Height [ft]	s_{anchor} [ft]	$w_p\ A_p$ [lb]	T_c [lb]	T_{cn} [lb]	DCR	Quick Check
Roof	WALL-P	38	0.00	WALL-R	106	4.04	4.00	1,714	2,647	7,555	0.35	OK
2nd	WALL-R	106	4.04	WALL-2	106	4.54	2.67	2,426	3,748	5,521	0.68	OK

OOP Wall Anchorage Detail: 1/S14 (2) 3/4" dia bolt @ 32" oc
Section: 8/S14 (2) 3/4" dia bolt @ 32" oc

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Profis Anchor 2.7.5

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Specifier:		Project:	
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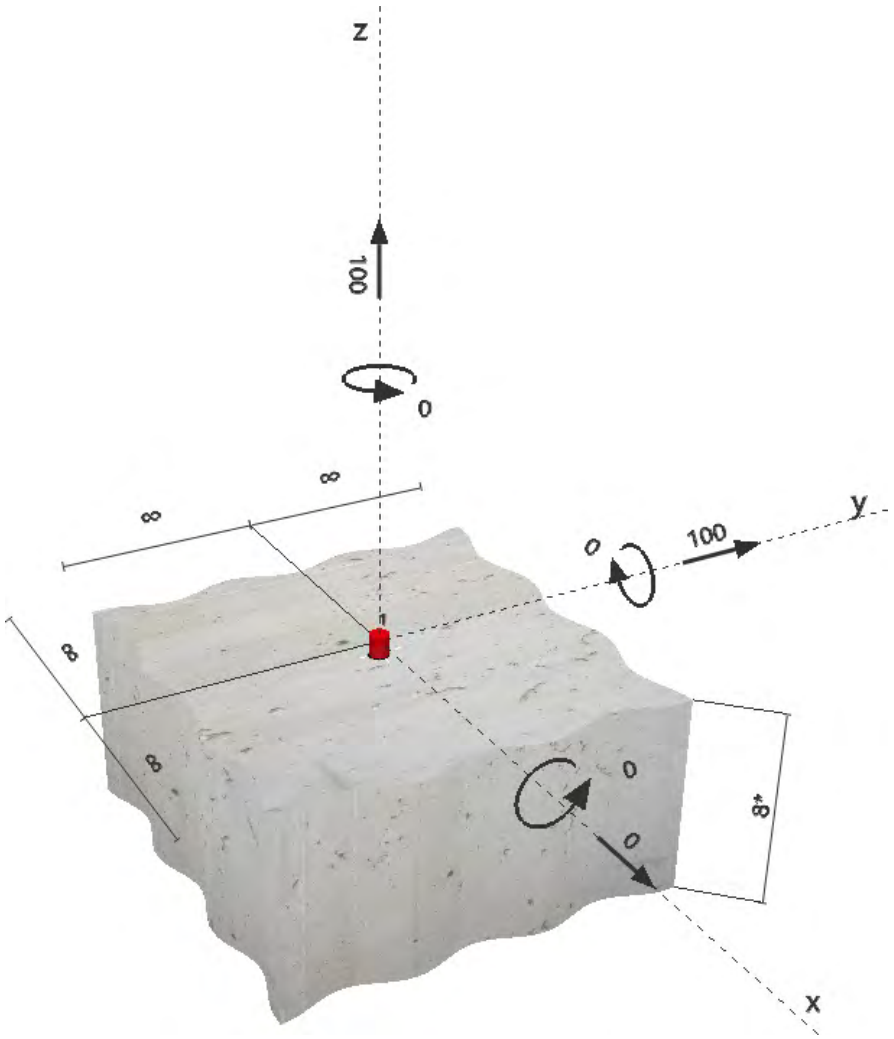
E-Mail:			

Specifier's comments:

1 Input data

Anchor type and diameter:	**Hex Head ASTM F 1554 GR. 36 3/4**
Effective embedment depth:	h_{ef} = 4.000 in.
Material:	ASTM F 1554
Proof:	Design method ACI 318-14 / CIP
Stand-off installation:	- (Recommended plate thickness: not calculated)
Profile:	no profile
Base material:	cracked concrete, 3000, f_c' = 3000 psi; h = 8.000 in.
Reinforcement:	tension: condition B, shear: condition B; edge reinforcement: none or < No. 4 bar
Seismic loads (cat. C, D, E, or F)	Tension load: yes (17.2.3.4.3 (d)) Shear load: yes (17.2.3.5.3 (c))

Geometry [in.] & Loading [lb, in.lb]



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2 Load case/Resulting anchor forces

Load case: Design loads

Anchor reactions [lb]
Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	100	100	0	100

max. concrete compressive strain: - [‰]
max. concrete compressive stress: - [psi]
resulting tension force in (x/y)=(0.000/0.000): 0 [lb]
resulting compression force in (x/y)=(0.000/0.000): 0 [lb]

3 Tension load

	Load N_{ua} [lb]	Capacity ϕN_n [lb]	Utilization $\beta_N = N_{ua}/\phi N_n$	Status
Steel Strength*	100	14529	1	OK
Pullout Strength*	100	8240	2	OK
Concrete Breakout Strength**	100	5521	2	OK
Concrete Side-Face Blowout, direction **	N/A	N/A	N/A	N/A

* anchor having the highest loading **anchor group (anchors in tension)

3.1 Steel Strength

$N_{sa} = A_{se,N} f_{uta}$ ACI 318-14 Eq. (17.4.1.2)
$\phi N_{sa} \geq N_{ua}$ ACI 318-14 Table 17.3.1.1

Variables

$A_{se,N}$ [in.^{2}]	f_{uta} [psi]
0.33	58000

Calculations

N_{sa} [lb]
19372

Results

N_{sa} [lb]	ϕ steel	ϕN_{sa} [lb]	N_{ua} [lb]
19372	0.750	14529	100

3.2 Pullout Strength

$N_{pN} = \psi_{c,p} N_p$ ACI 318-14 Eq. (17.4.3.1)
$N_p = 8 A_{brg} f'_c$ ACI 318-14 Eq. (17.4.3.4)
$\phi N_{pN} \geq N_{ua}$ ACI 318-14 Table 17.3.1.1

Variables

$\psi_{c,p}$	A_{brg} [in.^{2}]	λ_a	f'_c [psi]
1.000	0.65	1.000	3000

Calculations

N_p [lb]
15696

Results

N_{pn} [lb]	ϕ concrete	ϕ seismic	ϕ nonductile	ϕN_{pn} [lb]	N_{ua} [lb]
15696	0.700	0.750	1.000	8240	100

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3.3 Concrete Breakout Strength

$N_{cb} = \left(\frac{A_{Nc}}{A_{Nc0}}\right) \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b$ ACI 318-14 Eq. (17.4.2.1a)

$\phi N_{cb} \geq N_{ua}$ ACI 318-14 Table 17.3.1.1

A_{Nc} see ACI 318-14, Section 17.4.2.1, Fig. R 17.4.2.1(b)

$A_{Nc0} = 9 h_{ef}^2$ ACI 318-14 Eq. (17.4.2.1c)

$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2 e'_N}{3 h_{ef}}}\right) \leq 1.0$ ACI 318-14 Eq. (17.4.2.4)

$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5 h_{ef}}\right) \leq 1.0$ ACI 318-14 Eq. (17.4.2.5b)

$\psi_{cp,N} = MAX\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5 h_{ef}}{c_{ac}}\right) \leq 1.0$ ACI 318-14 Eq. (17.4.2.7b)

$N_b = k_c \lambda_a \sqrt{f'_c} h_{ef}^{1.5}$ ACI 318-14 Eq. (17.4.2.2a)

Variables

h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]	$\psi_{c,N}$
4.000	0.000	0.000	∞	1.000

c_{ac} [in.]	k_c	λ_a	f'_c [psi]
-	24	1.000	3000

Calculations

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
144.00	144.00	1.000	1.000	1.000	1.000	10516

Results

N_{cb} [lb]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	ϕN_{cb} [lb]	N_{ua} [lb]
10516	0.700	0.750	1.000	5521	100

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4 Shear load

	Load V_{ua} [lb]	Capacity ϕV_n [lb]	Utilization $\beta_V = V_{ua}/\phi V_n$	Status
Steel Strength*	100	7555	2	OK
Steel failure (with lever arm)*	N/A	N/A	N/A	N/A
Pryout Strength**	100	14723	1	OK
Concrete edge failure in direction **	N/A	N/A	N/A	N/A

* anchor having the highest loading **anchor group (relevant anchors)

4.1 Steel Strength

$V_{sa} = 0.6\, A_{se,V}\, f_{uta}$ ACI 318-14 Eq. (17.5.1.2b)
$\phi\ V_{steel} \geq V_{ua}$ ACI 318-14 Table 17.3.1.1

Variables

$A_{se,V}$ [in.^{2}]	f_{uta} [psi]
0.33	58000

Calculations

V_{sa} [lb]
11623

Results

V_{sa} [lb]	ϕ steel	$\phi\ V_{sa}$ [lb]	V_{ua} [lb]
11623	0.650	7555	100

4.2 Pryout Strength

$V_{cp} = k_{cp}\left[\left(\frac{A_{Nc}}{A_{Nc0}}\right)\psi_{ed,N}\,\psi_{c,N}\,\psi_{cp,N}\,N_b\right]$ ACI 318-14 Eq. (17.5.3.1a)
$\phi\ V_{cp} \geq V_{ua}$ ACI 318-14 Table 17.3.1.1
A_{Nc} see ACI 318-14, Section 17.4.2.1, Fig. R 17.4.2.1(b)
$A_{Nc0} = 9\, h_{ef}^2$ ACI 318-14 Eq. (17.4.2.1c)
$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2\, e'_N}{3\, h_{ef}}}\right) \leq 1.0$ ACI 318-14 Eq. (17.4.2.4)
$\psi_{ed,N} = 0.7 + 0.3\left(\frac{c_{a,min}}{1.5 h_{ef}}\right) \leq 1.0$ ACI 318-14 Eq. (17.4.2.5b)
$\psi_{cp,N} = \mathrm{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5 h_{ef}}{c_{ac}}\right) \leq 1.0$ ACI 318-14 Eq. (17.4.2.7b)
$N_b = k_c\, \lambda_a \sqrt{f'_c}\, h_{ef}^{1.5}$ ACI 318-14 Eq. (17.4.2.2a)

Variables

k_{cp}	h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]
2	4.000	0.000	0.000	∞

$\psi_{c,N}$	c_{ac} [in.]	k_c	λ_a	f'_c [psi]
1.000	-	24	1.000	3000

Calculations

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
144.00	144.00	1.000	1.000	1.000	1.000	10516

Results

V_{cp} [lb]	ϕ concrete	ϕ seismic	ϕ nonductile	$\phi\ V_{cp}$ [lb]	V_{ua} [lb]
21033	0.700	1.000	1.000	14723	100

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5 Combined tension and shear loads

β_N	β_V	ζ	Utilization $\beta_{N,V}$ [%]	Status
0.018	0.013	5/3	1	OK

$\beta_{NV} = \beta_N^{\zeta} + \beta_V^{\zeta} <= 1$

6 Warnings

- The anchor design methods in PROFIS Anchor require rigid anchor plates per current regulations (ETAG 001/Annex C, EOTA TR029, etc.). This means load re-distribution on the anchors due to elastic deformations of the anchor plate are not considered - the anchor plate is assumed to be sufficiently stiff, in order not to be deformed when subjected to the design loading. PROFIS Anchor calculates the minimum required anchor plate thickness with FEM to limit the stress of the anchor plate based on the assumptions explained above. The proof if the rigid base plate assumption is valid is not carried out by PROFIS Anchor. Input data and results must be checked for agreement with the existing conditions and for plausibility!
- Condition A applies when supplementary reinforcement is used. The Φ factor is increased for non-steel Design Strengths except Pullout Strength and Pryout strength. Condition B applies when supplementary reinforcement is not used and for Pullout Strength and Pryout Strength. Refer to your local standard.
- Checking the transfer of loads into the base material and the shear resistance are required in accordance with ACI 318 or the relevant standard!
- An anchor design approach for structures assigned to Seismic Design Category C, D, E or F is given in ACI 318-14, Chapter 17, Section 17.2.3.4.3 (a) that requires the governing design strength of an anchor or group of anchors be limited by ductile steel failure. If this is NOT the case, the connection design (tension) shall satisfy the provisions of Section 17.2.3.4.3 (b), Section 17.2.3.4.3 (c), or Section 17.2.3.4.3 (d). The connection design (shear) shall satisfy the provisions of Section 17.2.3.5.3 (a), Section 17.2.3.5.3 (b), or Section 17.2.3.5.3 (c).
- Section 17.2.3.4.3 (b) / Section 17.2.3.5.3 (a) require the attachment the anchors are connecting to the structure be designed to undergo ductile yielding at a load level corresponding to anchor forces no greater than the controlling design strength. Section 17.2.3.4.3 (c) / Section 17.2.3.5.3 (b) waive the ductility requirements and require the anchors to be designed for the maximum tension / shear that can be transmitted to the anchors by a non-yielding attachment. Section 17.2.3.4.3 (d) / Section 17.2.3.5.3 (c) waive the ductility requirements and require the design strength of the anchors to equal or exceed the maximum tension / shear obtained from design load combinations that include E, with E increased by ω_0.

Fastening meets the design criteria!

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7 Installation data

Anchor plate, steel: -
Profile: -
Hole diameter in the fixture: -
Plate thickness (input): -
Recommended plate thickness: -
Drilling method: -
Cleaning: No cleaning of the drilled hole is required

Anchor type and diameter: Hex Head ASTM F 1554 GR. 36 3/4
Installation torque: -
Hole diameter in the base material: - in.
Hole depth in the base material: 4.000 in.
Minimum thickness of the base material: 5.000 in.

Coordinates Anchor in.

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	0.000	0.000	-	-	-	-

8 Remarks; Your Cooperation Duties

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UC Santa Cruz Tier 1

Latitude, Longitude: 36.99752620, -122.05373821

Date	6/4/2019, 9:11:34 AM
Design Code Reference Document	ASCE41-17
Custom Probability	
Site Class	D - Default (See Section 11.4.3)

Type	Description	Value
Hazard Level		BSE-2N
S_S	spectral response (0.2 s)	1.638
S_1	spectral response (1.0 s)	0.629
S_{XS}	site-modified spectral response (0.2 s)	1.965
S_{X1}	site-modified spectral response (1.0 s)	1.069
F_a	site amplification factor (0.2 s)	1.2
F_v	site amplification factor (1.0 s)	1.7
ssuh	max direction uniform hazard (0.2 s)	1.758
crs	coefficient of risk (0.2 s)	0.932
ssrt	risk-targeted hazard (0.2 s)	1.638
ssd	deterministic hazard (0.2 s)	3.026
s1uh	max direction uniform hazard (1.0 s)	0.69
cr1	coefficient of risk (1.0 s)	0.912
s1rt	risk-targeted hazard (1.0 s)	0.629
s1d	deterministic hazard (1.0 s)	1.032

Type	Description	Value
Hazard Level		BSE-1N
S_{XS}	site-modified spectral response (0.2 s)	1.31
S_{X1}	site-modified spectral response (1.0 s)	0.713

Type	Description	Value
Hazard Level		BSE-2E
S_S	spectral response (0.2 s)	1.287
S_1	spectral response (1.0 s)	0.488
S_{XS}	site-modified spectral response (0.2 s)	1.545
S_{X1}	site-modified spectral response (1.0 s)	0.885
f_a	site amplification factor (0.2 s)	1.2
f_v	site amplification factor (1.0 s)	1.812

Type	Description	Value
Hazard Level		BSE-1E
S_S	spectral response (0.2 s)	0.696
S_1	spectral response (1.0 s)	0.245
S_{XS}	site-modified spectral response (0.2 s)	0.865
S_{X1}	site-modified spectral response (1.0 s)	0.517
F_a	site amplification factor (0.2 s)	1.243
F_v	site amplification factor (1.0 s)	2.11

Type	Description	Value
Hazard Level		T-Sub-L Data
T-Sub-L	Long-period transition period in seconds	12

Appendix C
Photos and Details

University of California, Santa Cruz
ASCE 41-17 Tier 1 Seismic Evaluation
CAAN 7133 - Cowell College Faculty Wing

Figure 1 - View from NW corner of the building

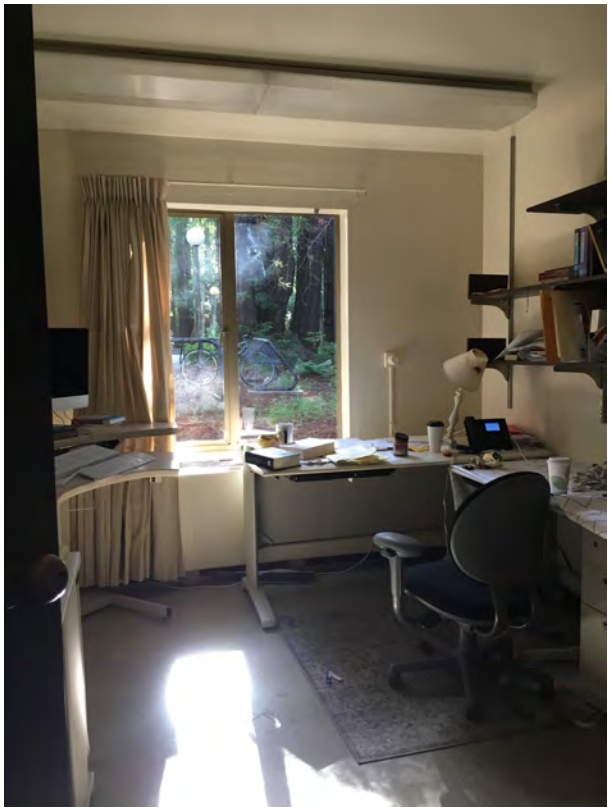

Figure 2 - Interior view of a typical office

University of California, Santa Cruz
ASCE 41-17 Tier 1 Seismic Evaluation
CAAN 7133 - Cowell College Faculty Wing

Figure 3 - Concrete bridge

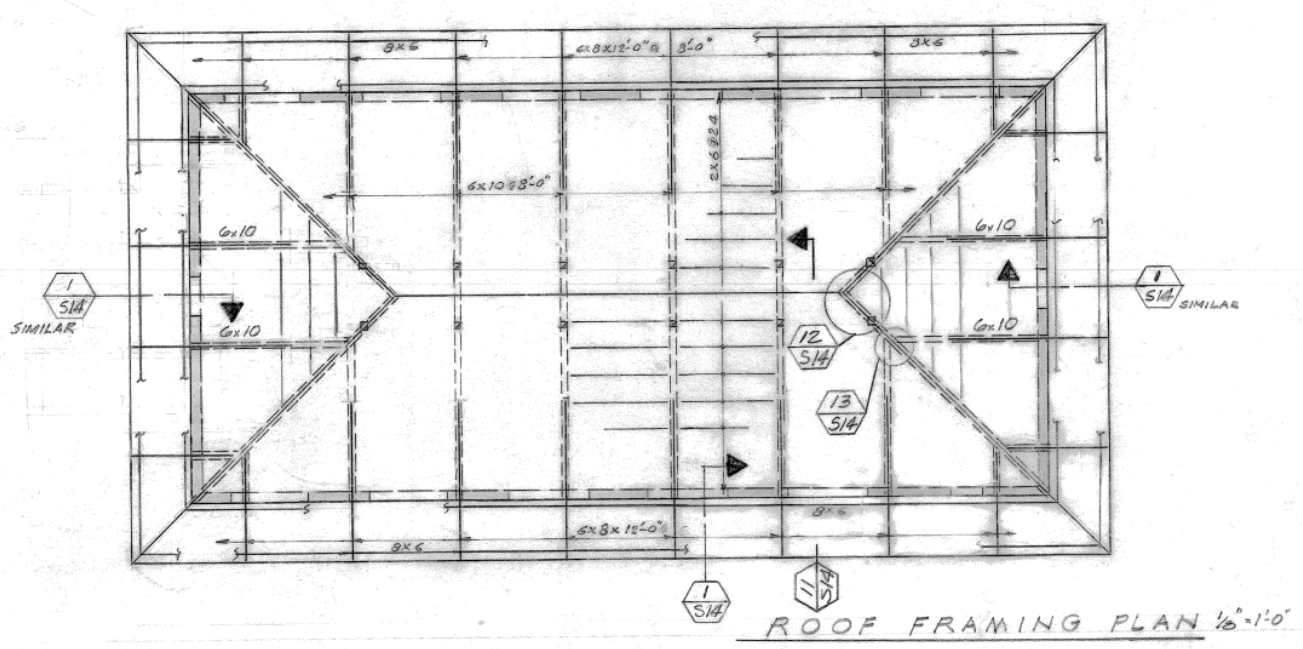

Figure 4 - Roof Framing Plan

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ASCE 41-17 Tier 1 Seismic Evaluation
CAAN 7133 - Cowell College Faculty Wing

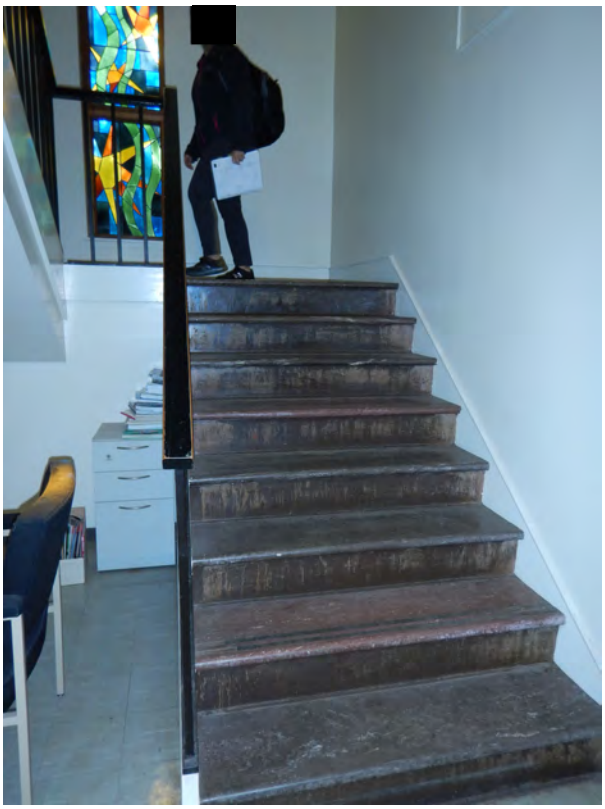

Figure 5 - Stairs at NE corner of the building

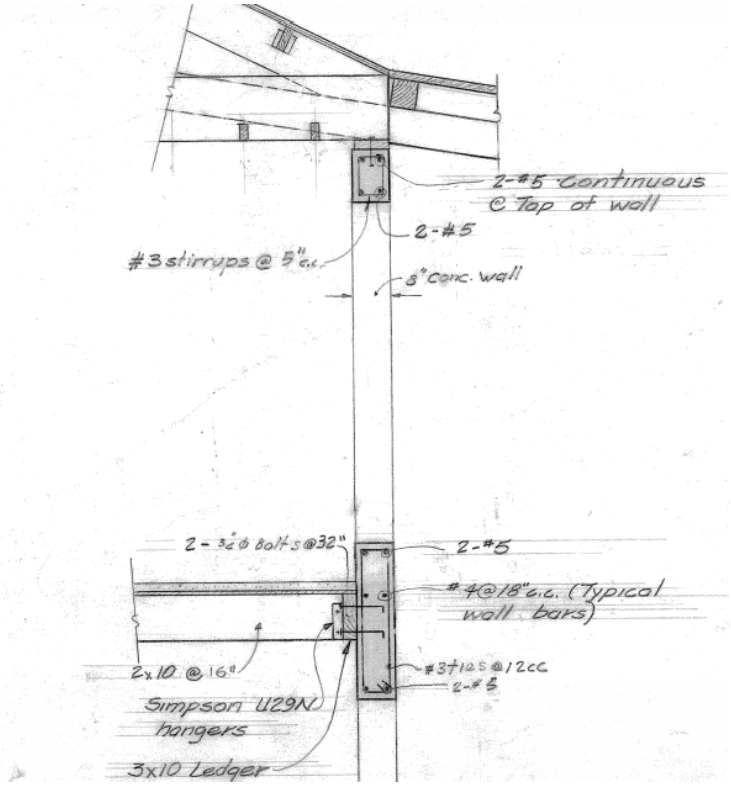

Figure 6 - Detail 1/S14 - Diaphragm to Wall Connection

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ASCE 41-17 Tier 1 Seismic Evaluation
CAAN 7133 - Cowell College Faculty Wing

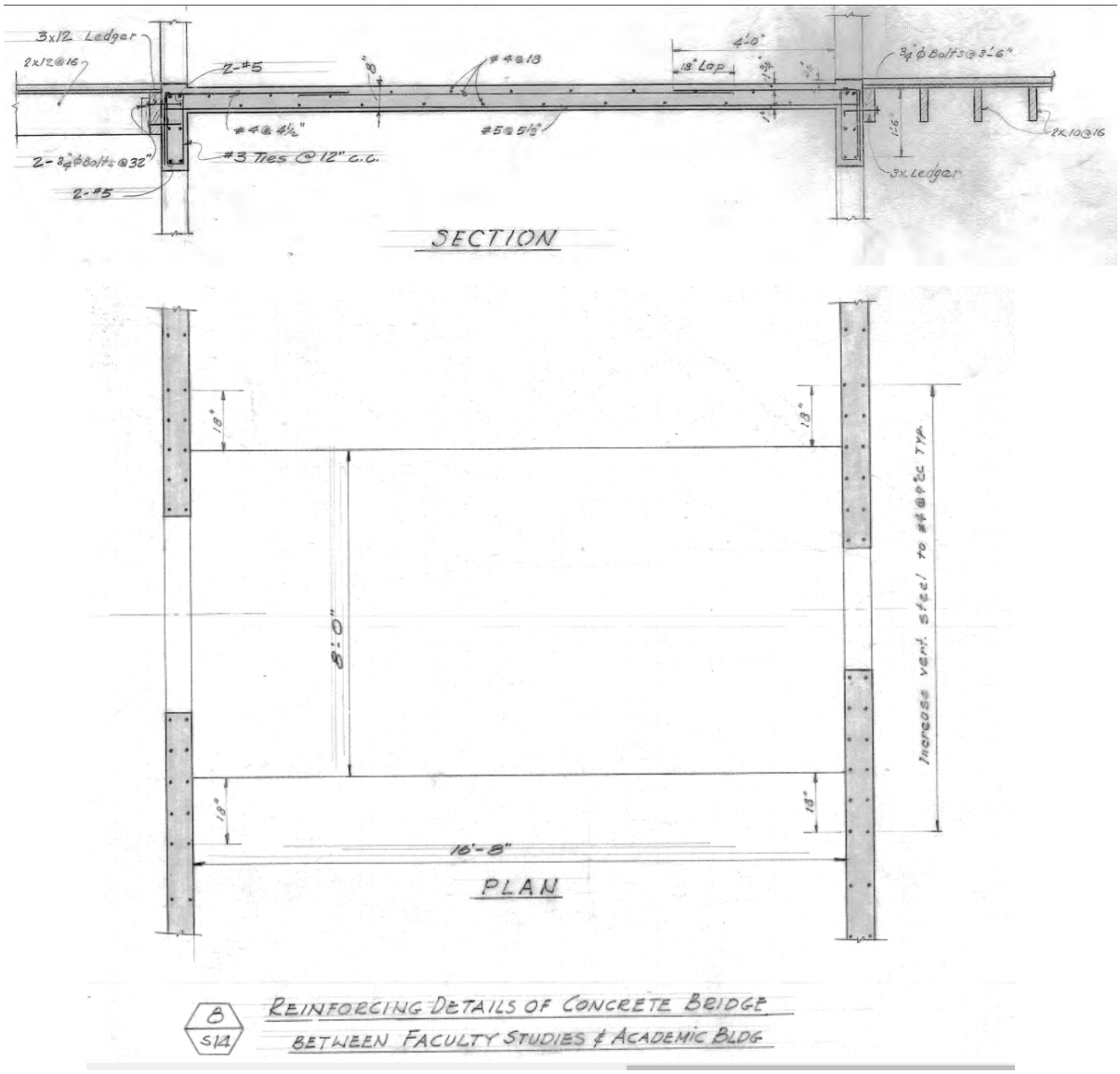

Figure 7 - Detail 8/S14 - Concrete Bridge Section Detail